



MPE Evaluation for AR7594 Wireless Module

October 25, 2017

1. Introduction

In this application we seek modular approval for the AR7594 radio module. This Maximum Permissible Exposure (MPE) report demonstrates compliance analysis for AR7594 radio module with FCC CFR 47 §2.1091 and IC RSS-102 for operation in mobile exposure conditions. The MPE analysis is limited for US bands only.

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure.

Any collocated transmitter must have a valid FCC ID with the collocated parameters defined in this MPE report. A separation distance of 20cm or more shall be maintained between the end user and each collocated transmitting antenna.

2. RF Exposure Limits and Equations

FCC RULES:

According to FCC OET Bulletin 65 Supplement C, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1307.

Table 1: Limits for Maximum Permissible Exposure (MPE)

(B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f ²)*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz *Plane-wave equivalent power density

EQUATIONS:

Power density is given by:

$$S = \text{EIRP} / (4 * \text{Pi} * D^2)$$

where S = Power density (mW/cm²)

EIRP = Equivalent Isotropic Radiated Power (mW)

D = Separation distance (cm)

3. AR7594 Product Specs

AR7594 will transmit on only one band and mode of operation at any one time. Table 3 lists the supported frequency bands in USA and the maximum power in each of those bands.

Technology	Band	UL Freq. (MHz)	DL Freq. (MHz)	Max Power
LTE	B7	2500 – 2570	2620 – 2690	25.2 dBm

Table 3: AR7594 Frequency Bands and Output Power

4. Stand-Alone Transmission

When AR7594 module transmits as a stand-alone mobile device, the source-based time-averaged EIRP is calculated by summing up conducted power and antenna gain. A 100% duty cycle is used for calculations to present a worse-case analysis. The antenna gains are chosen so that the resulted radiated power levels are within the limits specified by the FCC rules and IC Radio Standards Specifications (RSS). The IC exemption limits for routine RF exposure evaluation are calculated using the lowest frequency of the operating band presenting the most stringent limits.

As shown in Table 5 below, the resulted EIRP are always below the IC exemption limits for all the operating modes.

Model	Technology	Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Conducted Power (W)	Maximum Antenna Gain (dBi)	Duty Cycle	Average EIRP (dBm)	Power Density @ 20cm (mW/cm ²)	FCC MPE Limit (mW/cm ²)
AR7594	LTE B7	2500 – 2570	25.2	0.331	5.0	100%	30.2	0.208	1.000

Table 5: AR7594 Standalone Transmission

4. Collocated Transmission

When AR7594 module co-transmits with radio transmitter(s) as a mobile device, per KDB 447498 D01, simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is ≤ 1.0 .

The evaluation here considers a WiMAX or WLAN transmitter, and a Bluetooth transmitter as collocated transmitters. Their radiated output power levels are listed in Table 6 below. The MPE ratio is defined by the ratio of power density to MPE limit. The sum of the MPE ratios is calculated as follows:

$$\begin{aligned} \Sigma MPE \text{ Ratio} &= \text{Max (AR7594 MPE ratio)} + \text{Max (WLAN/WiMax MPE ratio)} + \text{BT MPE Ratio} \\ &= 0.208 + 0.100 + 0.006 = 0.314 < 1.0 \end{aligned}$$

	Technology	Frequency (MHz)	Maximum Conducted Power (dBm)	Maximum Conducted Power (W)	Maximum Antenna Gain (dBi)	Duty Cycle	Average EIRP (dBm)	Power Density @ 20cm (mW/cm ²)	FCC MPE Limit (mW/cm ²)	FCC PwrDensity MPE Ratio
AR7594	LTE B7	2500 – 2570	25.2	0.331	5.0	100%	30.2	0.208	1.000	0.208
Other Collocated Transmitters	WLAN	2400 -2500				100%	25.00	0.063	1.000	0.063
	WLAN	5150 -5850				100%	27.00	0.100	1.000	0.100
	WiMax	2300 -2400				100%	25.00	0.063	1.000	0.063
	WiMax	2500 -2700				100%	25.00	0.063	1.000	0.063
	WiMax	3300 -3800				100%	25.00	0.063	1.000	0.063
	BT	2400 -2500				100%	15.00	0.006	1.000	0.006

Table 6: AR7594 Collocated Transmission

5. Conclusion

The analysis presented in this report concludes that the AR7594 radio module, when transmitting either in standalone or simultaneously with other co-located radio transmitters within a host device, is compliant with the IC RF exposure requirements in mobile exposure condition, provided the conducted power and antenna gain do not exceed the limits in Table 4 for each given frequency band and operating mode.

	Technology		Frequency (MHz)	Maximum Antenna Gain (dBi)		EIRP Limits (dbm)
				Standalone	Collocated	
AR7594	LTE B7		2500 – 2570	5	5	
Collocated Transmitters	WLAN		2400 -2500			25
	WLAN		5150 -5850			27
		WiMAX	2300 -2400			25
		WiMAX	2500 -2700			25
		WiMAX	3300 -3800			25
	BT	BT	2400 -2500			15

Table 7: AR7594 RF Exposure Conditions